Attorney Docket No. 0076091-000008

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of	)	**MAIL STOP**
Brooks, Paul Joseph et al.	)	**APPEAL BRIEF PATENTS**
Application No.: 10/584,407	)	Group Art Unit: 1783
Filed: June 26, 2006	)	Examiner: Khatri, Prashant J.
For: Thermal Control Film for Spacecraft	)	Confirmation No.: 9864

APPEAL BRIEF

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

This appeal is from the decision of the Primary Examiner dated June 10, 2011 finally rejecting claims 1, 4, 6-10, 14-18, 21, 23, and 24, which are reproduced as the Claims Appendix of this brief.

☒ Charge ☐ $ 310.00 (2402) ☒ $ 620.00 (1402) to Credit Card. Fee being paid concurrent with the filing of this Appeal Brief.

The Commissioner is hereby authorized to charge any appropriate fees under 37 C.F.R. §§1.16, 1.17, and 1.21 that may be required by this paper, and to credit any overpayment, to Deposit Account No. 02-4800.

Table of Contents

I. Real Party in Interest

Astrium Limited of Stevenage, Hertfordshire, United Kingdom is the real party in interest, and is the assignee of Application No. 10/584,407.

II. Related Appeals and Interferences

The Appellant's legal representative, or assignee, does not know of any other appeal or interferences that will affect or be directly affected by or have bearing on the Board's decision in the pending appeal.

III. Status of Claims

A. There are 13 total claims currently pending in the application.

B. Current status of the claims

1. Claims canceled: 2, 3, 5, 11-13, 19, 20, and 22
2. Claims withdrawn from consideration but not canceled: None
3. Claims pending: 1, 4, 6-10, 14-18, 21, 23, and 24 and
4. Claims allowed: None
5. Claims rejected: 1, 4, 6-10, 14-18, 21, 23, and 24
6. Claims on appeal: 1, 4, 6-10, 14-18, 21, 23, and 24

IV. Status of Amendments

No Amendments were filed subsequent to the final Office Action dated June 10, 2011.

V. Summary Claimed Subject Matter

As shown in Figs. 1-5, an exemplary antenna has an active face on which a thermal control film is disposed (pg. 10, lines 8-12). The thermal control film has a polymeric multi-layer structure that includes a set of interference filters (pg. 8, lines 21-24). The layer structure of the thermal control film includes a stack of alternating

high and low refractive index dielectric films (pg. 5, lines 19-21). The thermal control film has a low absorbency of solar radiation, and a high absorbency and emissive characteristic in the infrared wavelength range 2.5μm to 50μm, which corresponds to the spectrum of heat generated by the high frequency circuits of the antenna array (pg. 8, lines 24-32). The film also exhibits a high transparency to the microwave frequencies, typically 1 to 30 GHz (pg. 8, lines 30-32).

The table that follows maps Appellant's independent claims to those portions of the disclosure that support the recited feature.

Claim #	Claim element	Support
1	An antenna comprising: an active face, at least one radiating element for transmitting radio frequency (RF) signals via the active face, and a metal free thermal control film covering the active face, the metal free thermal control film comprising: a multi-layer interference filter having alternating higher and lower refractive index layers arranged to filter optical radiation based on interference effects between different components of the optical radiation produced by reflection at boundaries between the layers, said control film exhibiting preselected high absorbency and emissive characteristics in an infrared wavelength range between 2.5μm to 50μm and low absorbency characteristics in a solar spectrum range between 200nm to 2500nm to limit solar input and allow heat dissipated in the antenna to be radiated into space via the active face, the control film further exhibiting high transmissive characteristics in a microwave frequency spectrum 1 to 30GHz to allow the RF signals to be transmitted via the active face.	pg. 10, lines 8-12 pg. 5, lines 19-21; pg. 8, lines 21-32

Claim #	Claim element	Support
23	A spacecraft antenna comprising an active face comprising at least one radiating element for transmitting radio frequency (RF) signals, and a metal free thermal control film covering the active face, the metal free thermal control film comprising a multi-layer interference filter having alternating higher and lower refractive index layers arranged to filter optical radiation based on interference effects between different components of the optical radiation produced by reflection at boundaries between the layers, said control film exhibiting sufficiently high absorbency and emissive characteristics in an infrared wavelength range 2.5 µm to 50 µm and sufficiently low absorbency characteristics in a solar spectrum range 200nm to 2500nm to limit solar input and allow heat dissipated in the antenna to be radiated into space via the active face, the control film further exhibiting sufficiently high transmissive characteristics in a microwave frequency spectrum 1 to 30 GHz to allow through RF signals transmitted by said at least one radiating element.	pg. 10, lines 8-12 pg. 5, lines 19-21; pg. 8, lines 21-32

Claim #	Claim element	Support
24	A spacecraft antenna comprising an active face comprising at least one radiating element for transmitting radio frequency (RF) signals, and a metal free thermal control film covering the active face, the metal free thermal control film comprising a multi-layer interference filter having alternating higher and lower refractive index layers arranged to filter optical radiation based on interference effects between different components of the optical radiation produced by reflection at boundaries between the layers, said control film being configured to absorb and emit radiation in an infrared wavelength range 2.5 μm to 50 μm to dissipate waste heat produced by active components of the antenna into space via the active face, said control film being configured to reflect solar radiation to limit solar input via the active face, and, the control film further being configured to transmit radiation in a microwave frequency spectrum 1 to 30 GHz to allow through RF signals transmitted by said at least one radiating element.	pg. 10, lines 8-12 pg. 5, lines 19-21; pg. 8, lines 21-32

VI. Grounds of Rejection to be Reviewed on Appeal

Whether:

1. Claims 1, 4, 6-10, 14-18, 21, and 23 are indefinite under 35 U.S.C. §112, second paragraph;

2. Claims 1, 4, 6, 9-10, 14, 21, 23, and 24 are unpatentable over *Rogers et al* (U.S. Patent No. 4,479,131) in view of *Jonza et al.* (U.S. Patent No. 5,882,774) with evidence from *3M™ Radiant Mirror Film VM2000F1A6 Product Sheet* ("3M Product Sheet") under 35 U.S.C. §103(a); and

3. Claims 7, 8, and 15-18 are unpatentable over *Rogers* in view of *Jonza* with evidence from the 3M Product Sheet, and further in view of *Iacovangelo et al.* (US 6,587,263).

VII. Argument

1. The terms "High" and "Low"

U.S. Patent No. 6,587,263 ("the '263 patent), which is discussed in the Background section of Appellant's disclosure, describes an optical solar reflector (OSR) that includes, among other features, a radiative layer 108. The radiative layer 108 is described as being chosen to have "low absorbency or electromagnetic radiation", which "avoids heating the spacecraft due to absorption of this energy" (Emphasis added, col. 4, lines 3-19). The radiative layer 108 also has high absorbency and emissivity in an infrared wavelength range. Absorbency (α) values in an electromagnetic range of 200 nm to 2500 nm and emissivity (E) values in an infrared range of 2.5 μm to 25 μm were determined through tests (See Table A).

TABLE A

Alpha and emissivity values of PECVD coating on Ag

Coating	Thick (μm)	α	E	α/E
SiO_2	12.8	0.184	0.811	0.226
$SiO_{1.14}N_{0.57}$	16.7	0.073	0.854	0.085
$SiO_{0.8}N_{0.8}$	16.8	0.070	0.857	0.082
$SiO_{0.5}N$	16.5	0.068	—	—
SiO_3N_4	13.6	0.083	0.847	0.098
standard	50	0.075	0.846	0.088

In the final rejection, the Examiner argues that the values for emissivity and absorbency are not applicable to the thermal film recited Appellant's claims because the film described in the '263 patent is of a different material. While Appellant acknowledges that the material disclosed in the '263 patent and the thermal material recited in Appellant's claims are different, this difference is irrelevant to the evidence that the '263 patent provides regarding an exemplary range of values. One of ordinary skill would have understood the manner of quantify "high absorbency", "high emissivity", and "low absorbency" as recited in the claims.

Emissivity (ε) is the ratio of the radiation emitted by a Blackbody at certain temperature and the radiation emitted by the object under analysis at the same temperature (*See* Exhibit A: "Emissivity: The Common Problem for all Thermographers", InfraMation, vol. 3, issue 4, pg. 1, April 2002). Good radiators have an emissivity closer to 1, whereas poor radiators have an emissivity closer to 0. Thus, the determination of emissivity for a material is well within the knowledge of one of skill in the art where high emissivity would be regarded as those values closer to 1 and low emissivity as those values closer to 0.

At the time of filing, one of ordinary skill in the art would have known that absorbency is the fraction of light absorbed by a sample (*See* Exhibit B: "Principles of Spectrophotometry", <http://www.ruf.rice.edu/~bioslabs/methods/protein/spectrophotometer.html>, David R. Caprette, Rice University September 16, 1996, Updated May 19, 2005). If light is directed on one face of a material and no light is detected on an opposite face then the absorbency of the material would be 100%. On the other hand, if the intensity of light detected at the opposite face is the same is the intensity emitted at the light

source then the absorbency of the material is 0%. Thus, for any given material and particularly for the thermal material recited in Appellant's claims, it would have been well within the purview of one of skill in the art to establish the absorbency of the thermal material such that those values closer to 100% would represent high absorbency and those values closer to 0% would represent low absorbency.

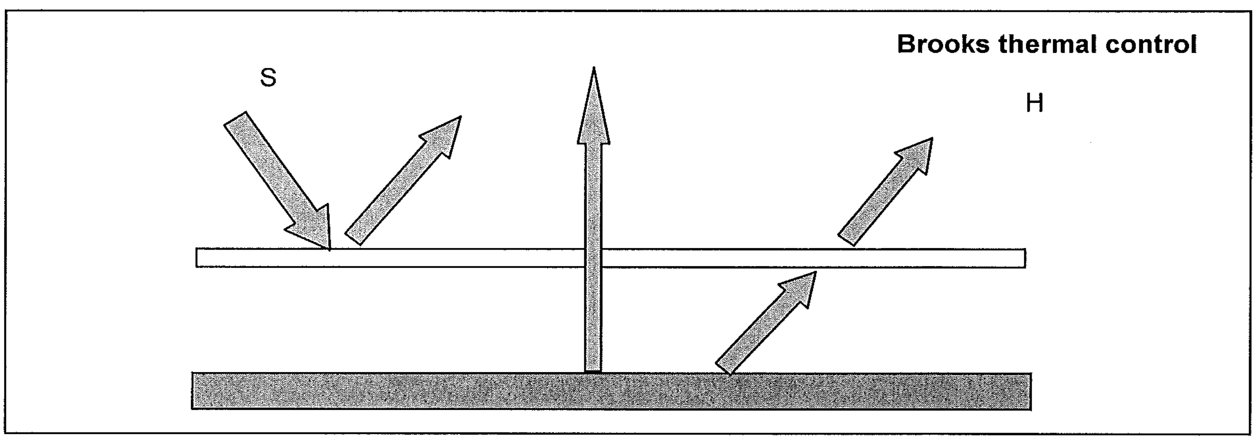
Given the knowledge of one of skill in the art at the time of filing, it should be understood that the values in TABLE A of the '236 patent are not relied upon to show the exact values that the thermal material embodied in the claims would exhibit. Rather, because the scale for determining at least emissivity would have been known to one of skill in the art, and is standardized for all materials this same person of skill would have been able to ascertain a corresponding high or low value of emissivity as claimed and provided in the context of Appellant's disclosure. In other words, despite the type of material used, because the scale used to measure emissivity and absorbency is standardized it follows that the determination of whether a material has high or low emissivity or absorbency is not based upon a reference value for the respective material but rather upon the values of a respective material with regard to the standardized scale. Additionally, the absorbency of the Appellant's claimed thermal material could have been established through routine measures.

For these reasons, Appellant believes that the terms "high" and "low" as recited in Appellant's claims are clear, precise, and otherwise definite.

2. <u>The combination of *Rogers* and *Jonza* does not disclose or suggest "a control film exhibiting preselected high absorbency and emissive characteristics in an infrared wavelength range between 2.5μm to 50μm and low absorbency characteristics in a solar spectrum range between 200nm to 2500nm to limit solar input and allow heat dissipated in the antenna to be radiated into space via the active face</u>"

Appellant maintains that the prior art combination, and particularly, *Rogers* fails to disclose or suggest an antenna having an active face, and a thermal film being provided on the active face, as recited in Appellant's claim 1.

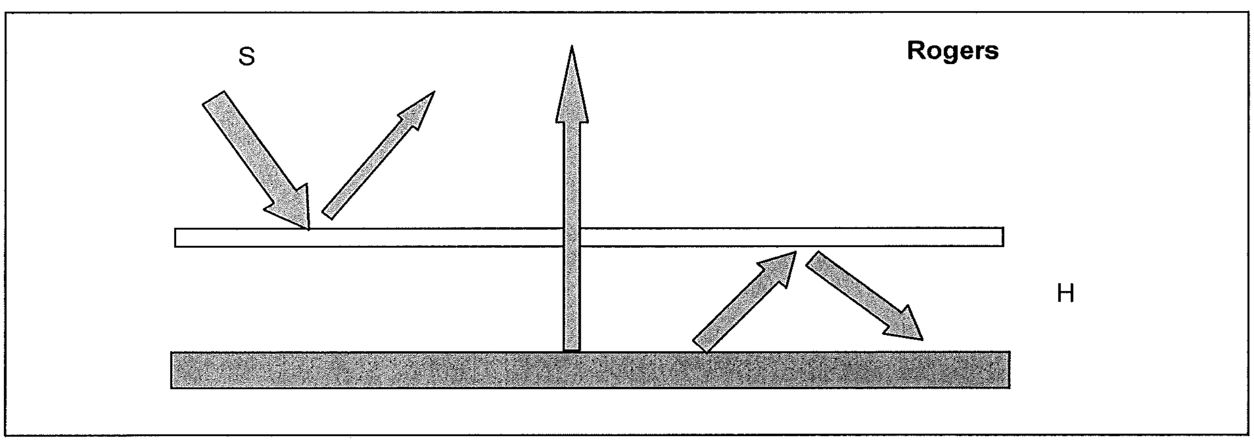
The embodiments as recited in Appellant's independent claims are directed to an active antenna system that generates and transmits the spacecraft RF signal (see inset e.g., Brooks thermal control). An "active" antenna system is one that consumes electrical power to create, process, and transmit the RF signal.



An active antenna generates a significant amount of waste heat as part of the generation of the RF signal and must be efficiently radiated away from the antenna into space without overheating the active antenna. Through the combination of features recited therein, the claimed embodiments reflect away sunlight, to allow transmission of the RF signal and the transmission of heat generated in the antenna.

Interference filter technology is used to produce a reflectivity of at least 80%, which leads to a lower absorbed solar heat load and therefore a greater ability to deal with the heat generated in the active antenna.

Rogers discloses a thermal shield positioned in front of an antenna reflector. The shield comprises a semiconductor optical coating and a capacitive grid on a substrate. The shield is provided on a passive reflector to focus signals onto a receiver (col. 2, lines 6-11; Fig. 1). The optical coating is designed such that not all solar energy will be absorbed by the coating on the sun side of the shield and to prevent heating of the shield. The optical coating also provides for the shield radiating heat, resulting from the absorbed solar energy, back into space (col. 2, lines 60-68). The combination of a capacitive aluminum grid and the optical coating/film provide the desired emissive characteristics, as the optical coating is



provided to reduce solar transmittance and the capacitive grid stops the solar radiation (col. 4, lines 18 to 23; see "Rogers" inset).

One of skill in the art would have understood that Rogers discloses the use of an RF transparent thermal blanket for an antenna reflector that passively reflects RF energy generated elsewhere in the spacecraft. This thermal blanket impedes heat flow and therefore does not allow the waste heat to be dumped to space without a

large rise in temperature. As a result, the temperature of the antenna would be too high and the system would be unviable. In the final Office Action, the Examiner alleges that the arrangement of *Rogers* comprises an active face that is disposed on the side of the antenna disposed in front of the RF transmitter (See Office Action, June 10, 2011, pg. 10). However, because a reflective antenna cannot create, process, and transmit an RF signal none of the faces of the antenna can reasonably be deemed an active face. *Rogers* does not disclose any face of the described reflecting antenna that comprises at least one radiating element as recited in Appellant's claims.

Moreover, the coating described in *Rogers* is only disclosed with reference to having high thermal emittance in the infrared radiation range corresponding to absorbed solar energy. Rogers fails to provide any guidance concerning how the coating would handle infrared radiation, incident from the reflector side, in the IR spectrum range (2.5um to 25um). This energy range corresponds to excess heat generated by the electronic devices within the antenna itself. Based on the configuration of the coating and the lack of discussion in *Rogers*, it appears that IR energy resulting from the electronic devices would be trapped by the shield. Consequently, the coating of *Rogers* does not appear to be suitable for an active face that comprises radiating elements as is embodied in Appellants' claims.

Jonza discloses an optical film having a multilayered polymeric sheet with alternating layers of polyethylene naphthalate and a polymer that is a reflective polarizer or mirror. The multilayer construction as shown in Fig. 1b includes alternate low and high index thick films having no tuned wavelengths or bandwidth constraints. The preferred multilayer stack ensures that wavelengths that would be

most strongly absorbed by the stack are the first wavelengths that would be most strongly absorbed by the stack.

However, neither *Jonza* nor the *3M Product Sheet* provides motivation to modify a film such that it can be provided on an active face in order to let RF signals out, along with the waste heat, while also minimizing the heat generated by incident radiation from the sun. Stated differently, the combination of *Rogers*, *Jonza*, and the 3M Product Sheet fails to disclose or suggest "said control film exhibiting preselected high absorbency and emissive characteristics in an infrared wavelength range between 2.5μm to 50μm and low absorbency characteristics in a solar spectrum range between 200nm to 2500nm to limit solar input and allow heat dissipated in the antenna to be radiated into space via the active face", as recited in independent claims 1, 23, and 24. Moreover, these documents would not have guided one of skill in the art with regard to modifying the shield of *Rogers* into a film that can be used on an active face. The skilled artisan would not have looked to modify the shield of *Rogers* to emit IR radiation as recited in Appellant's claims because the shield is provided on a passive reflector and would not be required to emit heat generated by active components within the antenna.

In summary, *Rogers*, *Jonza*, and the *3M Product Sheet* when applied individually or collectively fail to disclose or suggest every feature and/or the combination of features recited in Appellant's claims. For these reasons and those discussed in detail above, a *prima facie* case of obviousness has not been established. Withdrawal of the rejection to independent claims 1, 23, and 24 and dependent claims 4, 6, 9-10, 14, and 21 is respectfully requested.

3. *Iacovangelo* does not remedy the deficiencies of *Rogers* and *Jonza*

Claims 7, 8, and 15-18 variously depend from claim 1. By virtue of this dependency, these claims are distinguishable over the applied combination of references because *Iacovangelo* fails to remedy the deficiencies of *Rogers*, *Jonza*, and *the 3M Product Sheet* identified above. Moreover, the subject claims are deemed to be further distinguishable over the applied references due to the respective additional features recited therein. Withdrawal of this rejection, therefore, is respectfully requested.

VIII. Claims Appendix

See attached Claims Appendix for a copy of the claims involved in the appeal.

IX. Evidence Appendix

Evidentiary Exhibits A and B are provided with this Appeal.

X. Related Proceedings Appendix

No related proceedings are associated with this Appeal.

XI. Conclusion

Appellant has pointed to errors in the rejection of the claims. Appellant respectfully requests that the final rejection be reversed and the application be returned to the Examiner for prompt allowance.

Respectfully submitted,

BUCHANAN INGERSOLL & ROONEY PC

Date December 7, 2011 By: /Shawn B. Cage/
Registration No. 51522

Customer No. 21839
703 836 6620

VIII. CLAIMS APPENDIX

<u>The Appealed Claims</u>

1. An antenna comprising:

an active face, at least one radiating element for transmitting radio frequency (RF) signals via the active face, and a metal free thermal control film covering the active face, the metal free thermal control film comprising:

a multi-layer interference filter having alternating higher and lower refractive index layers arranged to filter optical radiation based on interference effects between different components of the optical radiation produced by reflection at boundaries between the layers, said control film exhibiting preselected high absorbency and emissive characteristics in an infrared wavelength range between 2.5μm to 50μm and low absorbency characteristics in a solar spectrum range between 200nm to 2500nm to limit solar input and allow heat dissipated in the antenna to be radiated into space via the active face, the control film further exhibiting high transmissive characteristics in a microwave frequency spectrum 1 to 30GHz to allow the RF signals to be transmitted via the active face.

4. The antenna according to claim 1, wherein the film is in the form of a flexible sheet.

6. The antenna according to claim 1 wherein the multi-layer interference filter is a polymeric structure.

7. The antenna according to claim 1, wherein the multi-layer interference filter comprises one or more layers of any of combination of SiO_2, SiO_xN_y, and Si_3N_4.

8. The antenna according to claim 7, wherein the film is in the form of a plurality of tiles.

9. The antenna according to claim 1, wherein a thickness of the film is less than 200 microns.

10. The antenna according to claim 1, wherein a thickness of the film is in the range of 50 to150 microns.

14. The antenna according to claim 4 wherein the multi-layer interference filter is a polymeric structure.

15. The antenna according to claim 14, wherein the multi-layer interference filter comprises one or more layers of any of combination of SiO_2, SiO_xN_y ,and Si_3N_4.

16. The antenna according to claim 15, wherein the film is in the form of a plurality of tiles.

17. The antenna according to claim 16, wherein the thickness of the film is less than 200 microns.

18. The antenna according to claim 17, wherein the thickness of the film is in a range of 50 to150 microns.

21. The antenna according to claim 1 wherein the film is formed by applying a liquid coating to a surface of a spacecraft.

23. A spacecraft antenna comprising

an active face comprising at least one radiating element for transmitting radio frequency (RF) signals, and

a metal free thermal control film covering the active face, the metal free thermal control film comprising a multi-layer interference filter having alternating higher and lower refractive index layers arranged to filter optical radiation based on interference effects between different components of the optical radiation produced by reflection at boundaries between the layers, said control film exhibiting sufficiently high absorbency and emissive characteristics in an infrared wavelength range 2.5 μm to 50 μm and sufficiently low absorbency characteristics in a solar spectrum range 200nm to 2500nm to limit solar input and allow heat dissipated in the antenna to be radiated into space via the active face, the control film further exhibiting

sufficiently high transmissive characteristics in a microwave frequency spectrum 1 to 30 GHz to allow through RF signals transmitted by said at least one radiating element.

24. A spacecraft antenna comprising

an active face comprising at least one radiating element for transmitting radio frequency (RF) signals, and

a metal free thermal control film covering the active face, the metal free thermal control film comprising a multi-layer interference filter having alternating higher and lower refractive index layers arranged to filter optical radiation based on interference effects between different components of the optical radiation produced by reflection at boundaries between the layers, said control film being configured to absorb and emit radiation in an infrared wavelength range 2.5 μm to 50 μm to dissipate waste heat produced by active components of the antenna into space via the active face, said control film being configured to reflect solar radiation to limit solar input via the active face, and, the control film further being configured to transmit radiation in a microwave frequency spectrum 1 to 30 GHz to allow through RF signals transmitted by said at least one radiating element.

IX. EVIDENCE APPENDIX

Exhibit A

INFRARED TRAINING CENTER

INFRAMATION

Infrared Training Center itc™

Volume 3, Issue 4
April, 2002

INFRAMATION CALL FOR PAPERS EXTENDED

Good news for those authors out there that needed some extra time to put that special paper together; we have extended the abstract due date for InfraMation! The new date is May 15, 2002. So don't delay!

You have the opportunity to be an active part of InfraMation 2002 as an author and presenter! We encourage you to participate by sharing your experiences with fellow and future thermographers.

We will have expanded exhibit areas and more of the very popular IR clinics. See the latest FLIR Systems cameras including the new E and P series cameras. InfraMation 2002 will be in Orlando, September 29 through October 2, 2002.

ABSTRACT DUE DATE: **MAY 15, 2002**

Notification of acceptance will be made by June 15, 2002

Abstracts must include:

- Author listing (principal author first)
- Abstract text (approximately 250 words)
- Brief principal author biography

MANUSCRIPT DUE DATE: **JULY 26, 2002**

SEND ABSTRACTS TO:

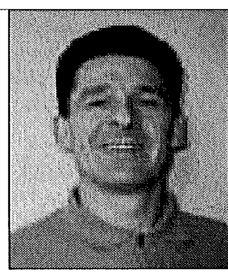
Infrared Training Center
16 Esquire Rd.
North Billerica, MA 01862
Attn: InfraMation 2002 Abstracts

abstracts@inframation.org◆

Inside this issue:

EMISSIVITY: THE COMMON PROBLEM FOR ALL THERMOGRAPHERS

By Roberto Rinaldi, ITC Italy



One of the most common questions asked by new thermographers is how to measure emissivity. Often there is a misunderstanding of emissivity and T_{amb} concepts, with obvious error on the measurement accuracy.

Other emissivity questions are related to measurements on metals such as:

- What is the emissivity for Aluminum, Copper or Iron, I found a table which is too wide? (surface condition and finish problem)
- I cannot get a proper thermal scale even though I am using the right emissivity value (0.25) for aluminium? (specific emissivity for measurement function not used or wrong T_{amb})
- I have a thermocouple on the component but the camera is reading far away from that value, why? (wrong T_{amb})

Definition

Emissivity (ε) is the ratio of the radiation emitted by a Blackbody (i.e. the camera calibration source) at certain temperature and the radiation emitted by the object under analysis at the same temperature.

Explanation

In simple words, it is the factor explaining how well an object radiates infrared energy; good radiators (i.e. objects easily seen by the camera) have an ε closer to 1. On the contrary, poor radiators (i.e. objects not easily seen by the camera) have an ε close to 0.

Emissivity depends on several factors. Here are several listed in their order of importance:

- Type of material
- Surface material finish (polished or oxidized)
- Surface geometry (cavity effect for instance)

Emissivity can also change for other reasons, but this is a less common measurement situation:

- Material temperature level
- Wavelength (IR short wave or long

(Continued on page 2)

EMISSIVITY (CONTD.)

(Continued from page 1)

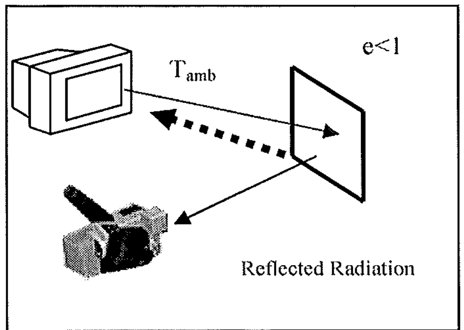
wave)

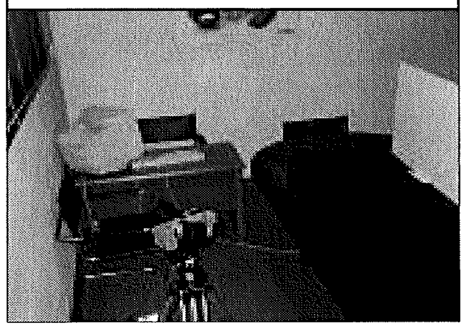
What exactly is T_{amb}?

An opaque object with a low emissivity value is a poor radiator but good reflector. This is the reason why it is so important to determine a correct T_{amb}. In all FLIR products there is a T_{amb} factor to input that is unfortunately misunderstood by the operators as a real temperature where the object or the camera are placed, or the room temperature as well. A better name for T_{amb} would be "Reflected apparent temperature". This is the apparent temperature of surfaces radiating to and reflecting off of the object under analysis, based on the camera recording position.

How to measure T_{amb}

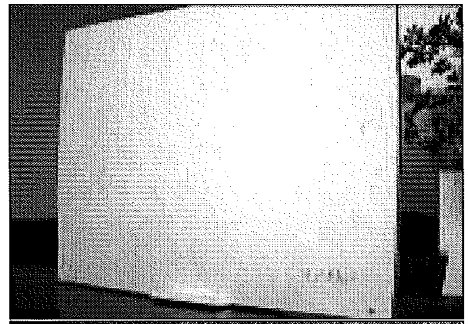
To measure T_{amb} we need to follow a few steps. Figures 1 and 2 describe an example of a measuring situation.

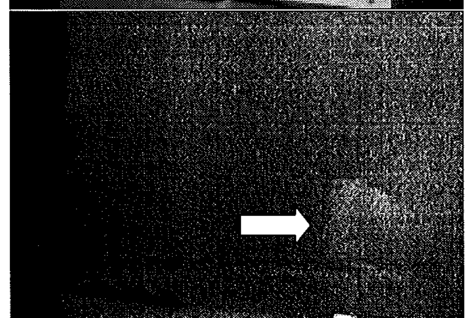




Figures 1 and 2. The monitor is reflecting its radiation onto the white board

1. Set ε=1 in the object parameters.
2. Set an area with the average read out (Spot meter if area function is not available)





Figures 3 and 4. The monitor reflection on the infrared image.

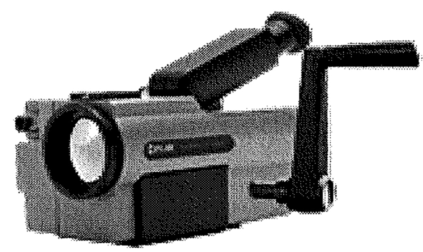
(Continued on page 3)

FLIR SYSTEMS INTRODUCES FIRST CRANK-POWERED INFRARED CAMERA

Puts the power of thermal imaging literally in your hands!

The HP (Human Power) 695 CrankIR™ utilizes a winding handle to energize a constant force spring. Sixty turns of the handle, taking 20-30 seconds, fully energizes the spring. The spring energy may be used to power the infrared camera directly, or to charge the battery. When used to charge the battery, consecutive spring discharge cycles may be dumped into the battery to increase its charge level.

One spring discharge provides 3 minutes of scanning time. Multiple spring discharges into the battery allows extended continuous operation. The spring may be stored indefinitely in the wound condition. This allows instantaneous thermal imaging operation whenever required. The spring is equipped with a mechanical brake. If the camera is switched off before the spring is fully discharged, any winding still on the spring will be preserved.



HP 695 CrankIR™

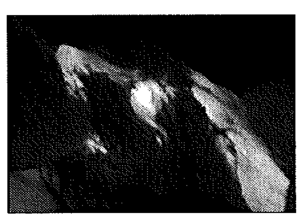
As if this isn't' enough, the built-in AM/FM radio may be operated during thermal imaging operation as well.◆

LAST MONTH'S BRAINTEASER

March's Brainteaser is a Police Dog Brigade (K9 Police Unit) at a night attack exercise of a "bad guy".

You see a car (wheel), and a helper ("criminal") who is attacked by a Bouvier des Flandres. Thanks to Herman Devos of Belgium for these thermograms.

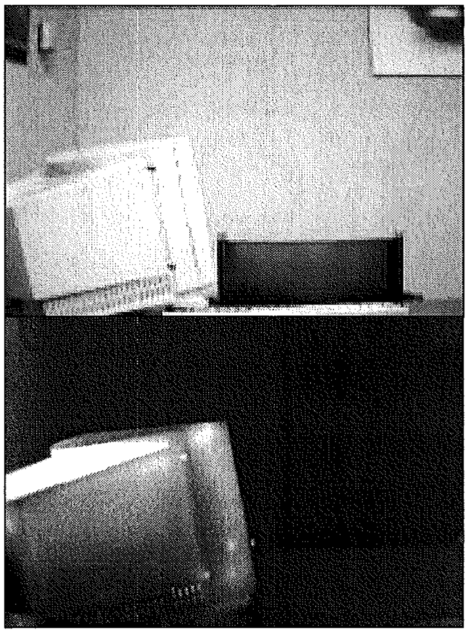
Congratulations to last month's winner, John Dunn of United Spectrographics in Little Rock, Arkansas. ◆



EMISSIVITY (CONTD.)

(Continued from page 2)

3. Place the camera against the back radiating surface to the object, according to the blue arrow shown in Figure 1.
4. Note the average area value (or, as an alternative, an average of several different spot readings)
5. Set that value in the object parameters.



Figures 5 and 6. The radiation produced by the monitor is part of T_{amb} together with the walls.

This procedure should always be carried out any time we want accurate object temperature measurement from our camera. We can then measure the object temperature, by setting the proper ε value for the object surface and aiming at the object itself.

Measuring object emissivity

To properly measure the object emissivity we need to go through the following procedure.

1. Place a material with a well known emissivity on the object like electrical tape (ε=0.95) or black paint: this will be our reference point.

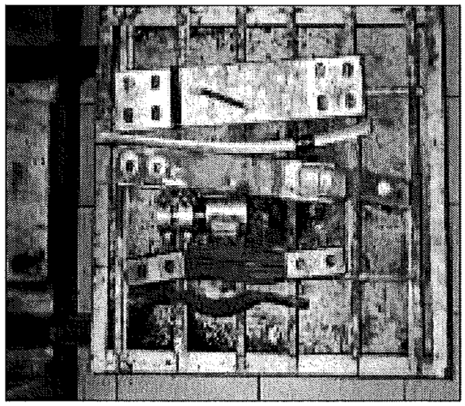


Figure 7. Electrical components taken out from the oven at 80°C

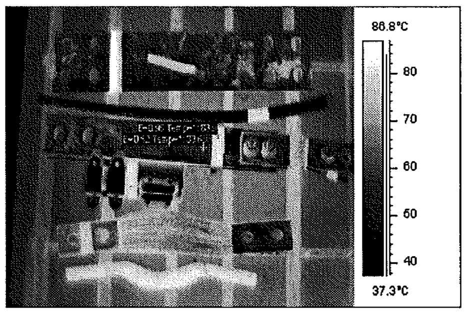
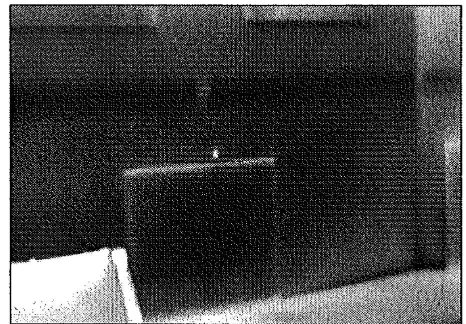
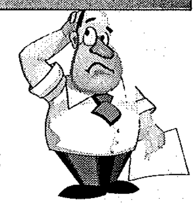


Figure 8. The spot meter reading on the tape is 83.9°C (e=0.95); the adjusted emissivity on the bar is 0.53 to get the same read out. In this way it is possible to calculate the Emissivity values for all the other components

2. Measure T_{amb} according to the general procedure described in the example above.
3. The object to be measured needs to be warmed up about at least 50° C above the room temperature. To do this we can use for an oven (Figure 7), or a tank with hot water, by submerging the object enclosed in a plastic bag.
4. Freeze the image of the warm object.
5. Set a spot meter on the reference emissivity point.
6. Set the correct emissivity and T_{amb} values in the object parameter table and note the spot read out.
7. Move the spot meter just outside the reference emissivity point.

BRAINTEASER OF THE MONTH



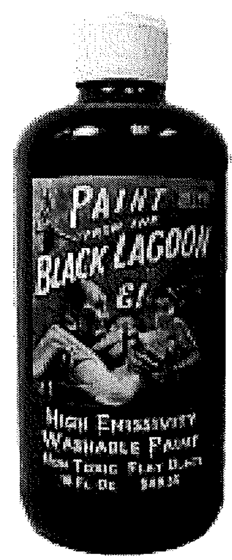


Here is this month's brainteaser. I am interested in the hot spot on the wall. First reader to email me with the correct explanation wins $20 in Infrabucks. Please put "Brainteaser" as the subject of the message.◆

Mailto: Gary.Orlove@infraredtraining.com

8. Adjust the Emissivity value in the object parameters to obtain the same spot reading noted in point 6. This is the wanted emissivity value.◆

HIGH EMISSIVITY WASHABLE PAINT



itc U.S.A., BOSTON

16 Esquire Road
N. Billerica, MA 01862, USA

Tel: +1-978-901-8405
Toll free: +1-866-TRAINIR
(866-872-4647)
Fax: +1.978.901-8832
E-mail:
mailto:info_us@infraredtraining.com

itc INTERNATIONAL, SWEDEN

Rinkebyvägen 19
SE-182 11 Danderyd, Sweden

Tel: +46 (0) 8 753 25 00
Fax: +46 (0) 8 753 26 01
E-mail: mailto:itc@flir.se

"Delivering world-class training and knowledge about thermography"

About the Infrared Training Center

The Infrared Training Center offers training and certification in all aspects of infrared thermography use. Our world-class training facilities are located near Boston, Massachusetts, USA and Stockholm, Sweden and have the world's most extensive hands on laboratories for infrared applications. Please join us in exploring the fascinating world of infrared!

Your comments and suggestions about this newsletter are welcomed and encouraged. If you have an interesting application or case study to share, we encourage you to submit it for publication.

Please e-mail mailto:Gary.Orlove@infraredtraining.com or regular mail to the USA office

itc ***INFRAMATION*** *- Editor / Designer: Gary Orlove*

Upcoming Classes - Americas

Remember we also teach customer site training courses at your convenience. Please contact us for more information.

April 2002
- 1-5 – Level I – Boston, MA
- 8-11 - Level II - New Orleans, LA
- 15-19 – Level I – Peru
- 15-19 – Level II – Boston, MA
- 22-25 – Level II – Denver, CO
- 22-26 – Level I – Mexico

May 2002
- 4/29-3 – Level I – Boston, MA
- 6-10 – Level I – Brazil
- 7-10 – Level III – Boston, MA
- 7-10 – Level I – Anchorage, AK
- 20-23 - Level I - Los Angeles, CA
- 20-23 - Level I - Montreal, Canada
- 21-24 – Level I – Lake Charles, LA
- 21-24 – Level I – Cleveland, OH
- 27-31 - Level I - Chile

June 2002
- 3-6 - Level II - Miami, FL
- 3-7 – Level I – Boston, MA
- 10-14 – Level II – Boston, MA
- 10-13 – Level II – Indianapolis, IN
- 24-27 – Level I – Las Vegas, NV
- 24-28 - Level I - Trinidad

July 2002
- 15-19 – Level I – Boston, MA
- 15-18 – Level I – Portland, OR
- 15-19 – Level I – Venezuela
- 22-25 – Level I – Nashville, TN
- 29-8/1 – Level I – Detroit, MI

Upcoming Classes - International

April 2002
- 15-19 - Level I - China
- 22-26 - Level I - Hong Kong
- 22-26 - Level I - UK
- 29-May 3 - Level I - Australia

May 2002
- 13-17 - Level I - Indonesia
- 20-24 - Level I - Japan

June 2002
- 3-7 - Level I
- 10-14 - Level II - South Africa
- 17-21 - Level II - UK
- 24-28 - Level I

July 2002
- 1-5 - Level I - Italy
- 1-5 - Level I - South Africa (ABB)

Upcoming Classes - Germany

April 2002
- 9-11 - R&D
- 22-24 - Operator CM
- 22-27 - Level I EN 473

May 2002
- 14-16 - Operator CM
- 14-16 - Level I EN 473 (part 1)
- 22-24 - Level I EN 473 (part 2)

June 2002
- 24-26 - Operator CM
- 24-29 - Level I EN 473

July 2002
- 9-11 - R&D
- 22-24 - Operator CM
- 22-27 - Level I EN 473

Upcoming Classes - France

April 2002
- 8-10 - Operator CM
- 22-24 - Operator CM

May 2002
- 27-29 - Operator CM

June 2002
- 10-12 - Operator CM

Exhibit B

Laboratory methods

Microscopy
Solutions & dilutions
Protein assays
Spectrophotometry & Beer's Law
Fractionation/ centrifugation

Absorbance assays: [absorbance at 280 nm] [absorbance at 205 nm] [extinction coefficient]
Colorimetric assays: [modified Lowry] [biuret] [Bradford] [Bicinchoninic Acid (Smith)]
Methods: [set up a standard curve] [spectrophotometry]

Principles of Spectrophotometry

Back Next

A spectrophotometer consists of two instruments, namely a *spectrometer* for producing light of any selected color (wavelength), and a *photometer* for measuring the intensity of light. The instruments are arranged so that liquid in a cuvette can be placed between the spectrometer beam and the photometer. The amount of light passing through the tube is measured by the photometer. The photometer delivers a voltage signal to a display device, normally a galvanometer. The signal changes as the amount of light absorbed by the liquid changes.

If development of color is linked to the concentration of a substance in solution then that concentration can be measured by determining the extent ofabsorption of light at the appropriate wavelength. For example hemoglobin appears red because the hemoglobin absorbs blue and green light rays much more effectively than red. The degree of absorbance of blue or green light is proportional to the concentration of hemoglobin.

When monochromatic light (light of a specific wavelength) passes through a solution there is usually a quantitative relationship (Beer's law) between the solute concentration and the intensity of the transmitted light, that is,

$$I = I_0 * 10^{-kcl}$$

where I sub 0 is the intensity of transmitted light using the pure solvent, I is the intensity of the transmitted light when the colored compound is added, c is concentration of the colored compound, l is the distance the light passes through the solution, and k is a constant. If the light path l is a constant, as is the case with a spectrophotometer, Beer's law may be written,

$$I \div I_0 = 10^{-kc} = T$$

where k is a new constant and T is the transmittance of the solution. There is a logarithmic relationship between transmittance and the concentration of the colored compound. Thus,

$$-\log T = \log 1/T = kc = \text{optical density (O.D.)}$$

The O.D. is directly proportional to the concentration of the colored compound. Most spectrophotometers have a scale that reads both in O.D. (absorbance) units, which is a logarithmic scale, and in % transmittance, which is an arithmetic scale. As suggested by

the above relationships, the absorbance scale is the most useful for colorimetric assays.

Using a Spectronic 20 spectrophotometer

The Spectronic 20 spectrometer is widely used in teaching laboratories. The specific instructions will differ with other models, but the principles remain.

1. The instrument must have been warm for at least 15 min. prior to use. The power switch doubles as the zeroing control.
2. Use the wavelength knob to set the desired wavelength. Extreme wavelengths, in the ultraviolet or infrared ranges, require special filters, light sources, and/or sample holders (cuvettes).
3. With the sample cover closed, use the zero control to adjust the meter needle to "0" on the % transmittance scale (with no sample in the instrument the light path is blocked, so the photometer reads no light at all).
4. Wipe the tube containing the reference solution with a lab wipe and place it into the sample holder. Close the cover and use the light control knob to set the meter needle to "0" on the absorbance scale.
5. Remove the reference tube, wipe off the first sample or standard tube, insert it and close the cover. Read and record the absorbance, **not** the transmittance.
6. Remove the sample tube, readjust the zero, and recalibrate if necessary before checking the next sample.

Why use a reference solution? Can't you just use a water blank? A proper reference solution contains color reagent plus sample buffer. The difference between the reference and a sample is that the concentration of the assayable substance in the reference solution is zero. The reference tube transmits as much light as is possible with the assay solution you are using. A sample tube with any concentration of the assayable substance absorbs more light than the reference, transmitting less light to the photometer. In order to obtain the best readability and accuracy, the scale is set to read zero absorbance (100% transmission) with the reference in place. Now you can use the full scale of the spectrophotometer. If you use a water blank as a reference, you might find that the assay solution alone absorbs so much light relative to distilled water that the usable scale is compressed, and the accuracy is very poor.

Back Next

Top

Created by David R. Caprette (caprette@rice.edu), Rice University 16 Sep 96
Updated 19 May 05

X. RELATED PROCEEDINGS APPENDIX

NONE